White Paper

Driving Return on Investment with Engineering Simulation Software on HPC Infrastructure

Sponsored by: Ansys and Intel

Jaclyn Ludema, Mark Nossokoff and Earl Joseph
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HYPERION RESEARCH OPINION

Investments in HPC infrastructure have contributed to scientific innovation and global competitiveness across a wide range of domains. Companies that leverage HPC to support their businesses can realize significant financial returns. Business returns can be calculated by measuring investments spent on the HPC resources compared with the projects' financial and innovation returns. The resulting return on investment (ROI) calculation provides insight into the monetary dynamics of various use cases of HPC applications.

The purpose of this white paper is to present the findings of a Hyperion Research ROI study, focused on CAE and EDA engineering simulation projects performed on HPCs, and provide an analysis of the current CAE and EDA market compared to the overall HPC manufacturing sector.

The projects in this study that leveraged HPCs to perform CAE and EDA engineering simulations saw returns from their HPC investments in terms of revenue, profit, cost savings, and/or innovation. The projects featured in this study are related to Ansys engineering simulation applications and characterized by their area of innovation, industry categorization, innovation category, and cloud utilization, providing additional insight into project ROIs and the types of projects that HPCs benefit.

Key findings of this engineering simulation software ROI study include:

- Results continue to indicate substantial returns of investments in HPC in Ansys engineering simulation applications
- On average $151.9 dollars in revenue per dollar of HPC invested was generated
- On average $34.9 dollars of profit (or cost savings) per dollar of HPC invested was generated
- The average HPC investment per engineering simulation innovation was $7.6 million
- The profit/cost savings ROI ratio for Ansys projects run primarily in the cloud was much higher than HPC projects run primarily on-premises

SITUATION ANALYSIS

Investing in HPC can be daunting for projects and programs looking to leverage the benefits of HPC for the first time. The pathway to an excellent HPC return on investments can be obscured by the larger barriers to entry relative to traditional computing, including large investments into HPC on-prem systems, time spent reserving system resource allocations for a research project, the additional time required to convert traditional workloads into HPC workloads, and the potential investments required in HPC training or hiring HPC expertise.

With support from the U.S. Department of Energy, Hyperion Research created the HPC Return on Investment (ROI) approach to help provide insight into HPC investments, by examining individual HPC projects and measuring the amounts spent on the HPC resources compared with the projects' financial and innovation returns. The ROI study includes:

- A macroeconomic model that depicts the way HPC investments result in economic advancements in the form of ROI in revenue, and profits (and cost savings). It looks at HPC costs as the input and revenues, profits or cost savings, and job creation as the output.
- A Return on Research (ROR) innovation class index that provides a means of measuring and comparing innovation levels based on two parameters: the importance of each innovation combined with how many organizations can use the innovation.

New research has expanded the HPC ROI body of work to include 71 additional CAE and EDA engineering simulation projects related to Ansys engineering simulation application run on HPC. This report provides ROI data and analysis of these Ansys projects and compares them to the existing Hyperion Research HPC ROI study, particularly the manufacturing sector.

Note that this research looks at the economic impacts based on the HPC investment compared with the output of revenue/sales and/or profits and cost savings. It excludes the additional costs of production, sales, etc. that are also required for each project.

Reporting on the ROI Numbers

The results of this study indicate that there are substantial returns on investment in HPC for Ansys applications:

- On average $151.9 in revenue per dollar of HPC invested was generated
- On average $34.9 of profit (or cost savings) per dollar of HPC invested was generated
- The average HPC investment per engineering simulation innovation was $7.6 million

When comparing the ROIs for projects of this study to the rest of the HPC market, engineering simulation falls into the manufacturing sector. Ansys HPC projects run primarily on-premises align with the rest of the HPC manufacturing market, with an average revenue ROI of $224.7 per dollar of HPC invested, compared to $216.5. and an average Profit/Cost Savings ROI of $29.7 per dollar of HPC invested, compared to $28.4.

Remarkably, the average profit/cost savings ROI for Ansys HPC projects run primarily in the cloud exceeds that of the overall HPC market, $55.6 per dollar of HPC invested, compared to $47.2. All projects in this study saw revenue from their projects using HPCs, and only 8% of projects saw less

revenue than the investment made into HPC. The table below shows the comparison of numbers found in this study and the larger HPC market side by side.

TABLE 1

Comparing the Engineering Simulation Application ROI to the HPC Market ROI

Study	ROI	Revenue per Dollar of HPC Invested	Profit (or Cost Savings) per Dollar of HPC Invested
Engineering Simulation ROI	Overall HPC ROI	$151.9	$34.9
	Hybrid on-premises and in the cloud	$45.7	$26.4
	Primarily in the cloud (>90%)	$70.1	**$55.6**
	Primarily on-premises (>90%)	**$224.7**	**$29.7**
Hyperion Research Market ROI	HPC Market ROI Study	$509.3	**$47.2**
	Manufacturing Industry Vertical of HPC Market ROI Study	**$216.5**	**$28.4**

n = 71

Notes: Engineering simulation projects run primarily on-premises have ROIs comparable to that of the manufacturing vertical in the Hyperion Research HPC market ROI study (blue and green). Engineering simulation projects that run primarily in the cloud exceed the average profit/cost savings ROI of HPC market (purple).

Source: Hyperion Research, 2023

CHARACTERIZING SUCCESSFUL PROJECTS USING HPC ENGINEERING SIMULATION APPLICATIONS

This study describes various attributes of the contributing projects and analyzes the types of projects that find success when utilizing HPC-enabled simulation applications. The attributes most noteworthy when cross sectioning the ROI numbers are innovation area, industry, innovation category, and cloud utilization.

Innovation Areas

The contributing projects in this study were divided by the types of advancements realized as a result of running Ansys simulation applications on HPC. These applications on HPC were primarily leveraged to make better products (40% of projects) and create cost savings (20% of projects). The average return on investment for these two innovation areas suggests why they are popular areas of focus;

innovations to make better products have an average revenue ROI ratio of 292.8, and profit/cost savings ROI ratio of 58.6, while innovations for cost savings have an average revenue ROI ratio of 20.6 and an average profit/cost savings ROI ratio of 21.3.

The data also suggests that innovations intended to open new market segments result in excellent revenue ROIs, and innovations used to realize a new capability or help society (sustainability e.g., reduce carbon footprint, and support net-zero emissions) produce both strong revenue and profit/cost savings ROIs. However, with only one project data point feeding each of these inferences they cannot be viewed as trends in the market, and in the future finding additional projects in these areas of innovation would be beneficial.

The table below presents the average revenue and profit/cost savings ROIs between the different areas of innovation together with a count of projects in each of the innovation areas.

TABLE 2

Categorizing Average Revenue and Profit/Cost Saving ROIs by Area of Innovation

Innovation Area	# of Projects	Average Revenue ROI Ratio	Average Profit/Cost Savings ROI Ratio
Helped Us Make Better Products	29	292.8	58.6
Cost Savings	14	20.6	21.3
Created a New Approach	10	15.2	4.5
Major Scientific Breakthrough	8	7.8	1.5
Discovered Something New	5	2.0	2.0
Helped Society - Sustainability	3	20.0	10.0
Opened New Market Segments	1	150.0	1.0
Realize a New Capability	1	42.9	21.4

n = 71

Notes: Making better products and cost savings were the top 2 areas that benefited from using HPC applications.

Source: Hyperion Research, 2023

Industry

Project respondents were asked to categorize their organization into an industry or sector, as well as the types of returns on investment seen by the project. Combining these two data sets describes the success of each industry and gives insight into the goal of the projects.

The Industrial Equipment Industry stands out as the revenue ROI leader, with an average of $983.9 of revenue per dollar invested into HPCs (3 projects total). The Healthcare Industry is the profit/cost savings ROI leader, with an average of $116.7 of profit/cost savings per dollar invested into HPCs.

Remarkably, all Industries have revenue and profit/cost savings ROIs ratio greater than 1, indicating success of engineering simulation investments into HPC regardless of Industry. When considering that 13% of the projects in this study were pursuing only financial ROI, the rest pursuing innovation or both, it is notable to see financial returns exceeding HPC investments for all Industries.

The table below looks at the different types of investments alongside the financial ROIs for the different industry sectors.

"Getting faster results allowed us to iterate to a better blade design faster. A fan design has infinite blade characteristics so being able to run as many as possible in as little time as possible helps tremendously in attaining a good blade design. Ansys Fluent combined with HPC packages helped us iterate to a new blade design in previously impossible time." – Industrial Equipment

TABLE 3

Types of ROIs and Average Financial ROIs Divided by Industry Classification

Industry	Financial ROI Only	Innovation Only	Both Financial & Innovation	Average Revenue ROI Ratio	Average Profit/Cost Savings ROI Ratio
Aerospace	2	6	7	26.3	2.7
Automotive & Ground Transportation	3	5	7	17.7	4.2
Consumer Products	1	1	2	120.9	73.3
Energy	2	0	2	329.5	57.8
Healthcare	0	4	5	126.3	116.7
High Tech	1	2	8	163.0	43.0
Industrial Equipment	0	0	3	983.9	37.5
Materials & Chemical Processing	0	2	2	42.9	21.4
Other	0	3	3	21.1	11.2
Total	9	23	39	151.9	34.9

n = 71

Note: All Industries evaluated in this study saw return on investments using engineering simulation HPC applications.

Source: Hyperion Research, 2023

Innovation Categories

The innovation categories separate the projects of this study into two categories, basic research and applied research, in an effort to understand where in a projects' timeline investing in HPCs is the most beneficial, and where returns are more likely to exist. Basic research includes major discoveries and pioneering breakthroughs, implying that HPC is being leveraged to find new solutions, while applied research includes incremental innovations and process improvements, which means at minimum a proof of concept has been discovered prior to the project and HPCs are being leveraged for optimization.

Applied research has an average revenue ROI ratio of 179.6, and a profit/cost savings ROI of 42.1, far exceeding the ROIs of basic research (32.1 and 3.9 respectively). For the purposes of innovation category analysis, a breakout of the numbers used to build an ROI paints a much more dynamic picture. The table below shows the project count, sum and average breakdowns of HPC investments, revenue, and profit/cost savings of applied research projects and basic research projects.

TABLE 4

HPC Investments, Total Revenue, and Profit/Cost Savings of Research Categories

	Applied Research, Including Incremental Innovations and Process Improvements	Basic Research, Including Major Discoveries and Pioneering Breakthroughs	Total
# of HPC Investments	55	16	71
Sum of HPC Investment ($M)	338	200	538
Average HPC Investment ($M)	6.2	13	8
# of Total Revenue/Sales	39	9	48
Sum of Total Revenue/Sales ($M)	5,756	1,312	7,068
Average Total Revenue/Sales ($M)	148	146	147
# of Profit/Cost Savings	39	9	48
Sum of Profit/Cost Savings ($M)	2,603	278	2,881
Average Profit/Cost Savings ($M)	67	31	60

Note: Average total revenue/sales of applied and basic research is similar, but profit for applied research is more than double. The HPC investment for applied research is less than half that of basic research, but more than 3 times more frequently pursued amongst survey respondents.

Source: Hyperion Research, 2023

The average total revenue/sales of applied and basic research are similar ($148M and $146M), however the average HPC investment required for basic research is more than double that of applied research. Logically this makes sense, as pioneering and discovery projects often require more trial-and-error work, which in the case of HPCs would mean more compute time and resources invested into the project.

Applied research stands out above basic research in terms of popularity and profit/cost savings revenue. Applied research is pursued three times more than basic research within this study. The average profit of applied research projects is $67M, more than double that of basic research ($31M).

Cloud Utilization

Characterizing the study's projects based on where their HPCs were run, in the cloud, on-premises, or a hybrid of the two is pertinent to the recent HPC market trend of growing cloud popularity. There are many reasons organizations are choosing to utilize HPC in the cloud, including access to the latest and greatest GPUs and accelerators, ease of use, less overhead costs, and scalability. Based on the projects in this study, organizations using HPC engineering simulation applications in the cloud can add profit/cost savings ROI to the list.

The average profit/cost saving ROI ratio for projects run in the cloud is 55.6, compared to 29.7 for on-premises run projects.

The first table below compares the average financial ROIs split by the three different cloud and on-premises configurations utilized by the projects in this study. The second table looks at the average profit/cost savings ROIs for applied and basic research projects, broken down by the three different cloud and on-premises configurations.

TABLE 5

Financial ROIs for Cloud and On-Premises Distributions

HPC Application Run Location	# of Sites	Average Revenue ROI Ratio	Average Profit or Cost Savings ROI Ratio
Primarily on-premises (>90% of runtime)	42	224.7	29.7
Primarily in the Cloud (>90% of runtime)	14	70.1	55.6
Hybrid On-premises and Cloud	15	45.7	26.4

n = 71

Note: 59% of HPC application software was run on-premises, the remaining 41% was evenly split between cloud and hybrid cloud runs.

Source: Hyperion Research, 2023

TABLE 6

Profit ROIs for Applied and Basic Research

HPC Application Run Location	Average Profit ROI Ratio Applied Research, including incremental innovations and process improvements	Average Profit ROI Ratio Basic Research, including major discoveries and pioneering breakthroughs
Primarily on-premises (>90% of runtime)	34.4	2.9
Primarily in the Cloud (>90% of runtime)	84.0	5.8
Hybrid On-premises and Cloud	29.3	N/A

n = 71

Note: Only one project in this study was considered basic research and took place on a hybrid on-premises and Cloud HPC system, therefore an average ROI could not be calculated.

Source: Hyperion Research, 2023

Twice as many basic research projects in this study are primarily run on-premises as in the cloud, however the profit/cost savings ROI ratio of basic research projects run in the cloud is double that of the on-premises projects (5.8 vs. 2.9). Utilizing the cloud to run HPC engineering simulations can be beneficial to profit/cost savings, particularly to applied research projects. The profit/cost savings ROI ratio for applied research innovation run on cloud is 84.0, eclipsing on-premises (34.4) and hybrid configurations (29.3).

Market Motivators for Using HPC Engineering Simulation Products and Services

Based on the projects in this study, the two key motivators for using HPC engineering simulation products and services are quick turnaround times and larger model capabilities.

Users are benefitting from the speed of HPC applications, which enables rapid prototyping of consumer products:

- Faster solve times allow for more design scrutiny, design tweaking, and improvement.
- HPC resources allow users to iterate at a much faster pace and perform optimization around simulated product designs.
- The ability to perform multiple simulations in parallel with different operating conditions allows users to quickly find the most likely optimal configuration.
- Utilization of HPC resources helps in processing large amounts of data and performing more complex calculations at high speeds.

- By utilizing HPC, they are able to build larger, more complex models that are more reflective of actual geometries and operating scenarios, which in turn delivered more accurate solutions in shorter times.
- HPC resources helped run computationally expensive meshes required for the multi-phase multi-physics simulation.

Multiple project users report that HPC-enabled simulation applications help to improve the productivity and the quality of the products:

- "Out antenna systems operate over an extremely wide frequency bandwidth. HPC makes possible the solution of computationally large problems within a practical timeframe." -- Clyde Callewaert, Senior Engineer, Herrick Technology Laboratories, Defense
- "Our HPC resources allowed us to run many advanced fluid dynamics simulations on various designs for the inhaler. Ansys fluent allows us to significantly optimize the design of our inhaler based drug delivery products Insilico while simultaneously reducing our prototype and testing costs." -- Scientific Computing Engineer from a leading Pharmaceutical Company
- "Jet in crossflow has a range of operating parameters over which the dynamics need to be studied. Current HPC capabilities and Ansys capabilities to use them have greatly enabled running many parallel simulation cases, each parallelized for an overall quick turnaround time." -- Senior Research Engineer, Georgia Tech, Aerospace
- "HPC resources allow us to iterate at a much faster pace and perform optimization around our designs. We are able to perform multiple simulations in parallel with different operating conditions and quickly find the most likely optimal configuration." -- Computational Fluid Dynamics scientist from a leading Fusion Energy Company

FUTURE OUTLOOK

HPC continues to be a demonstrated enabler of innovation across a wide range of important sectors that can drive significant returns on investments. Leveraging HPC infrastructure can provide substantial cost savings, considerable profits, and meaningful revenues for a wide range of businesses. Companies that are deploying engineering simulation software on HPC infrastructure to enable their engineers to create new innovative products are no exception.

Manufacturers that utilize engineering simulation software as a key part of their development process should continue to take note of the substantial business opportunities afforded by investments in HPC. Key to this is collaborating with ecosystem partners that understand both the domain area of the engineering that's occurring and the systems on which the software is being run.

Ansys is an example of a provider of engineering simulation software that understands the importance of supporting their customers' business need of driving returns on their investments. By providing a range of innovative engineering simulation software across a diverse set of domain areas and supporting both on-premises and cloud-based deployments, Ansys demonstrates the capabilities required to support engineers advancing innovation and generating returns for their organizations.

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology, and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). Hyperion Research provides thought leadership and practical guidance for users, vendors and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

Headquarters

365 Summit Avenue
St. Paul, MN 55102
USA
612.812.5798
www.HyperionResearch.com and www.hpcuserforum.com